

**UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE**

CONSERVATION PRACTICE STANDARD

WELL DECOMMISSIONING

(No.)

Code 351

DEFINITION

The sealing and permanent closure of a water well no longer in use.

PURPOSE

The purposes of this conservation practice are to preserve the quality of the groundwater resource, protect the public health, avoid unsafe conditions, and, restore (to the extent practical) the hydrogeological conditions that existed before the well was drilled.

This practice serves to:

- * Prevent entry of vermin, debris, or other foreign substances into the well or well bore hole;
- * Eliminate the physical hazard of an open hole to people, animals, and farm machinery;
- * Prevent entry of contaminated surface water into the well and migration of contaminants into unsaturated (vadose) zone or saturated zone;
- * Prevent the commingling of chemically or physically different groundwaters between separate water bearing zones;
- * Conserve yield and maintain hydrostatic head of aquifer.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to any drilled, dug, driven, bored, or otherwise constructed vertical water well determined to have no further beneficial use or whose use has been permanently discontinued.

This practice does not apply to:

- * Petroleum or geothermal wells.
- * Test wells for geologic investigation.
- * Wells that were used for waste disposal or wells having evidence of contamination from household garbage, pesticides, or other chemical or solid wastes.

DESIGN CRITERIA

General

All planned work shall comply with General Manual Title 450-GM, Part 405, Subpart A, Compliance with federal, state, and local laws and regulations. Public water systems which propose to abandon a water well must follow the American Water Works Association Standards on well abandonment. Refer to ASTM Standard Guide D 5299 for information on decommissioning procedures and properties of common well sealing materials.

The following criteria are allowable limits for design parameters, acceptable installation process, or minimum performance requirements for accomplishing all the identified purposes.

Data Collection

All available data for the well shall be collected. This includes length and diameter of the casing, total well depth, depth to water table, type of

liners and screens, and related information. Available drillers records are located in files at the Hydrogeology Division of the Geological Survey of Alabama in Tuscaloosa at 205-349-2852. The existing conditions of the well shall be documented as shown in the **"Plans and Specifications"** section. Data shall be recorded on NRCS Form AL-ENG-45 or AL-ENG-45a.

Well Preparation

The well shall be cleared of all pumping equipment, valves, pipelines, casing liners, debris, and other foreign materials.

Casing

The casing shall be pulled if at all possible. Casings removed from a collapsing formation shall be grouted concurrent with removal such that the bottom of the casing remains submerged in the grout. If the casing cannot be pulled out, one of the following will be required: 1) perforation - a slot or hole will be made in the well casing to allow for communication of fluids between the well and the annular space. The casing shall be perforated or ripped throughout the entire length of a confining layer.; or 2) overdrilling - drilling out the well casing and any material placed in the annular space. If the well was cement grouted, pulling the casing is not advisable, since the casing may shatter. Variation from these procedures will be allowed only with the approval of the state conservation engineer.

Disinfection

The well water shall be brought to a 100 ppm chlorine concentration before sealing. Household bleach can be used. Quantities can be determined using the guidelines listed in the **Construction Specifications**.

Sealing Materials

All materials used for sealing any portion of the well shall have a hydraulic conductivity equivalent to or less than that of the lowest hydraulic conductivity of the geologic materials being sealed. Where the geologic hydraulic conductivity is unknown, sealing material should have a maximum allowable hydraulic conductivity of 10^{-6} gpd/ft².

Sealing materials for use below the water table can include neat cement (various forms of portland cement) and various forms of bentonite. Materials suitable for use above the water table can include cement grout, neat cement, neat cement with additives (e.g., gypsum or aluminum powder) to prevent shrinkage, and various forms of bentonite.

Fill Materials

Fill materials can be used in lieu of sealing materials under certain conditions to reduce cost. The use of fill materials to plug a drilled well should be used only after careful examination of the drilling logs. Assistance from a trained geologist may be necessary.

Fill materials can include sand, pea gravel, sand-gravel mix, crushed stone, and agricultural lime, all of which shall be clean and free of organic or other foreign matter. Clay subsoil can be used in certain situations.

The gradation of fill materials shall be such that bridging does not occur during placement. To protect against bridging during placement, the maximum particle size of the fill materials should not exceed 1/10 of the well diameter. Materials greater than 3 inches should not be used regardless of the well diameter. For wells greater than 30 inches in diameter, backfill shall be placed in a manner that minimizes segregation and bulking in order to prevent surface subsidence.

Placement of Materials

All materials shall be placed in the well from the bottom upward, using a tremie pipe (grout pipe) if needed, in a manner that ensures continuous placement without air or water gaps or bridging. To determine the volume of materials needed per foot of depth, use the chart in the

Construction Specifications. Have available a minimum of 25% to 50% in excess of the calculated borehole volume in case loss of sealing material into the formation occurs. In areas where coarse materials are encountered, or considerable fracturing or solution openings occur, two or three times the calculated volume of material may be required to fill the hole.

Sealing Procedure

The entire well depth shall be filled with neat cement, cement grout, cement-bentonite slurry, or chipped or pelletized bentonite. For dug wells, in addition to the materials listed above, clean sand/gravel may be used below the water table. Local clay subsoil may be used above the water table. Other acceptable methods of sealing a well may be approved upon written request to the state conservation engineer.

Verification of Plug

To assure an abandoned water well or hole is sealed and sealed properly and that there has been no "bridging" of the material, calculations and measurements shall be made to determine whether the volume of the material placed in the well at least equals the volume of the casing or hole sealed.

Surface Seal

If the casing is not removed from the well, it should be cut off at a depth no less than 3 ft. below the ground surface. The 3 ft. interval below the top of the cut-off casing shall be sealed with cement.

Annular space around the outside of the well casing below the cutoff depth shall be grouted as needed. Wells with gravel exposed in the annular space at cutoff depth shall have at least a 3-foot depth of the gravel removed and the annular space backfilled with grout, bentonite chips or other expansive sealer.

The interval between the ground surface and the top of the cut-off casing shall be filled with soil materials that achieve an in-place hydraulic conductivity equivalent to or less than the surface soil surrounding the well. Backfill material shall be free of pesticide and waste contaminants. The ground surface at the sealed well site shall be mounded and graded in a manner that prevents ponding of surface runoff.

Vegetation

All areas which are disturbed during the decommissioning operation shall be smoothed and dressed at the completion of sealing the well. These areas shall be established with vegetation in accordance with the FOTG Standard for Critical Area Planting (342), unless the area is to be utilized for crop production.

CONSIDERATIONS

This practice may be part of a ground water protection system that includes water and chemical management practices.

To the extent practicable, an abandoned well should be decommissioned in a manner that restores the original hydrogeologic conditions of the well site and does not preclude the use of the site from future land management practices.

Decommissioning requires special consideration of specific geological, biological, and physical conditions, well construction practices, and chemical composition of the surrounding soil, rock, and groundwater at the well site. The selection of appropriate procedures, fill materials, and sealing materials should be made accordingly. For additional information on local conditions, discuss site conditions with drilling and well servicing contractors. Special equipment may be required; therefore, it is advisable that a qualified contractor perform the work.

In some Karst terrains, where large conduits may exist, it may be difficult to plug a well. Another consideration is that large quantities of sealing materials may cut off an underground stream or otherwise alter the hydrogeology.

Checking for contaminants is recommended. Waste oil, pesticides, and garbage are among some of the more common contaminants found in wells. Groundwater remediation (not covered in this standard) may be required. Pumping and removal of contaminants may prevent future widespread groundwater contamination problems. The Alabama Health Department or Alabama Department of Environmental Management should be contacted for guidance on remediation and sealing of contaminated wells.

Well sealing serves to protect the water, and animal (including human) resources. The effects of this practice on soil, air, and plant resources are expected to be minimal or non-existent.

PLANS AND SPECIFICATIONS

Plans and specifications for decommissioning abandoned water wells shall be consistent with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

A record of the installation of this practice shall be made on AL-ENG-45 or AL-ENG-45a and shall include the following information:

- * Location of the decommissioned well by latitude/longitude, township/range, or other georeference convention, of such precision that it can be readily located in the field, if required, in the future.
- * Date of well decommissioning
- * Name of landowner
- * Total depth of well
- * Inside diameter of well bore or casing
- * Casing material type or schedule (e.g., standard weight steel, or PVC sch-80)

- * Static water level measured from the ground surface
- * Type of materials used for filling and sealing, quantities used, and depth intervals for emplacement of each type.

OPERATION AND MAINTENANCE

The closed, abandoned well shall be inspected periodically by the landowner. A mound shall be maintained at the site so that surface water is directed away from the abandoned well location. Vegetation shall also be maintained except where the area is utilized for crop production. Any disturbed materials should be repaired or replaced as soon as possible to prevent further damage from occurring.

REFERENCES

ASTM D 5299-92

AWWA Standard for Deep Wells - AWWA A100-66

ADEM Administrative Code
335-7-5-13

EPA-57019-75-001 Manual of Water Well Construction Practices

ADEM - Water Well Standards Program
Code R. 335-9-1-.06(g)

CONSTRUCTION SPECIFICATIONS FOR WELL DECOMMISSIONING

SCOPE

This item shall include all plans, specifications, and construction operations required for the closing of abandoned wells. Construction operations shall be carried out in such a manner that erosion, air, water, and noise pollution will be minimized.

SPECIFICATIONS

Debris Removal

Before sealing begins, pumping equipment and any obstacles or debris shall be removed from the well. Dug wells shall be cleaned of debris and refuse using mechanical equipment from the ground surface. Casing that is not sealed should be removed, if possible. Driven and drilled wells should be flushed with water or compressed air if needed to remove materials which would hinder sealing operation.

Proper disposal of displaced fluids and other materials (such as pulled or drilled out casing and cement seals) should be considered. Some of these materials may be classified as hazardous waste under federal, state, or local regulations.

Measurement of Well Depth and Water Depth

The depth of the well and the depth of the water shall be measured after debris removal and before well sealing begins.

Safety Consideration

When sealing operations are temporarily suspended, such as overnight shut down or awaiting materials, the well or hole shall be covered. The cover shall be anchored to prevent easy or unintentional entry and sealed to prevent the seepage of surface water and foreign material into the well or hole. If a well pit must be entered, workers shall comply with all OSHA safety regulations. Hard hats should be worn around heavy equipment.

Chlorination

The water in the well shall be brought to a 100 ppm chlorine concentration before sealing.

A 100 ppm chlorine solution will require:

1 gal. 5% chlorine bleach per 500 gal. of water

1 pt. 5% chlorine bleach per 62 gal. of water

1.3 lbs. high-test calcium hypochlorite tablets per 1,000 gal.

To determine the volume of water in the well, use the chart shown under the Materials section.

Materials

An estimate of the amount of materials needed to plug the well should be calculated prior to construction.

An estimate of the borehole volume can be calculated as follows:

$$V = 3.1416 * D^2 * L/4$$

where:

V = volume (cu. ft.)

D = diameter of hole (ft.)

L = length of hole to be sealed (ft.)

To determine the volume of water in the well or the volume of materials needed per foot of depth, use the following chart.

Hole diameter (inches)	Volume per foot of depth	
	gal/ft	cu ft/ft
4	0.7	0.1
6	1.5	0.2
8	2.6	0.3
10	4.1	0.5
12	5.9	0.8
14	8.0	1.1
16	10.4	1.4
20	16.3	2.2
24	23.5	3.1
36	52.9	7.1
48	94.0	12.6

Materials used in decommissioning abandoned wells are as follows:

Bentonite. Predominantly composed of the clay mineral sodium montmorillonite which swells when wet. Pelletized bentonite consists of granular bentonite which has been compressed into tablets. Pelletized bentonite with a soluble coating is recommended for sealing wells. Chipped bentonite is raw mined in the form of chunks 1/4 to 3/4 inch in size. As bentonite chips are difficult to place, they should be used with caution. Granular and powdered forms of bentonite are not recommended for dry placement in well sealing operations.

Cement-bentonite slurry. A mixture of cement, bentonite, and water, consisting of not more than eight (8) percent bentonite by dry weight of the cement and a maximum of ten (10) gallons of water per sack (94 pounds) of cement.

Cement grout. Mixture of cement, sand (1:1 ratio) and water [not more than 6 gal. of water per sack (94 lbs.) of cement.]

Grout. Material consisting of bentonite, cement, or a cement-bentonite mixture.

High solids clay grout. Blend of powdered polymer-free bentonite clay mixed with water that forms a creamy slurry with a minimum of 20% solids by weight and a density of 9.4 lb./gal.

Local Clay Subsoil. Any clayey material of local origin found below the topsoil. It should have a medium or loamy texture or be classified a silty

clay (CL-ML) or lean clay (CL) in the Unified Soil Classification System.

Neat cement. Neat cement is a mixture of one bag (94 pounds or 1 cubic foot) of portland cement and 6 gal. of water. It is about the consistency of thick cream and can be pumped with special piston pumps. The mixture of one 94 lb. bag of cement and 6 gal. of water yields a volume of 1.1 cubic foot.

Sand. Sand shall be clean sand.

Sand/gravel mix. Material shall be clean. Gravel shall have a maximum size of 1/10 of the well diameter. Materials greater than 3 inches should not be used regardless of the well diameter.

The above mixtures may be varied to improve pumping, gravity flow, expansion, etc., as approved by the engineer.

Handling and Placement of Materials

Cement. If cement is used to seal the well, it shall continue to be placed to within 3 ft. of the ground surface. Cement shall be placed through a pipe from the bottom of the well. The pipe should be raised slowly as the cement is added. Complete this operation in one continuous operation. The cement mix will displace the water if installed with a pipe as specified. When the overflowing cement is similar to that being pumped down the hole, the sealing is considered complete. As a precaution, free-standing water present in the well prior to the placement of cement should be bailed or pumped out, if possible.

Neat cement is generally preferred to grout as it avoids the danger of separation.

Bentonite. If bentonite is used, it should be screened through a 1/4" mesh to remove dust and fine particles which would tend to clog when being added to the well. The bentonite should be added slowly at a rate of about one bag (50 lbs.) per five minutes to prevent bridging unless otherwise recommended. The bentonite should become saturated with water as it is placed in the well. If there is not sufficient water in the well to saturate the bentonite, water should be added at a rate of 8 gal. per bag.

Use bentonite chips or pellets only where it is practical to place. Bentonite chips and pellets have a tendency to stick to the damp side walls

of the well, causing bridging. Dry bentonite should be tamped in place to ensure bridging does not occur. In deep holes, one of the slurry materials should be used.

Use caution when using bentonite in saline ground water, due to shrinkage that may occur when in contact with high concentrations of salt.

Local Clay Subsoil. Compacted local clay subsoil shall be moist so as to obtain good compaction. The clay shall be compacted in 6 in. layers with a 2x4 or 4x4 board, a long pipe with a flat end, or other suitable tamping device.

Sand/Gravel Mix. If over 20 ft. of sand/gravel is used in filling the well above the water level seal, an intervening 3 ft. seal of bentonite or cement shall be placed about halfway in the sand column, or at 20 ft. intervals in deep wells.

Inspection

NRCS representative should be on-site during field activities to verify that the activities are completed as planned. Written certification of conformance to specifications will be required if physical inspection is not conclusive.

Sealing Procedure

The well casing and bore hole shall be completely filled with materials as specified in this standard, including the annular space outside of the casing or liner.

Surface seal. All wells will have a surface seal as follows:

A 3 ft. plug of cement shall be placed in the well to within 3 ft. of ground level, forming a seal from 6 ft. to 3 ft. below the surface.

A pit shall be excavated around the upper 3 ft. of the well. The pit diameter shall exceed the diameter of the casing by at least 4 feet. The casing, if it has not been pulled, should be cut off at the base of the pit. With dug wells, the upper 3 ft. of the well lining should be removed. The pit shall be backfilled with a 1.5 ft. thick layer of bentonite or cement-bentonite slurry. The 1.5 ft. of bentonite shall be overlain with compacted, low permeability soil, mounded to direct surface water away from the abandoned well location. The mounded soil shall be sodded or seeded with appropriate vegetation and mulched, unless the area is to be utilized for crop production.

Well Pits. To properly abandon a well pit, knock in at least one wall, breakup or perforate the floor, and then fill the pit using the procedure for dug wells.